CLAIMS

1. A method for calculating values for pixels of an image, comprising:

calculating sample values for pixels of an image in accordance with a sampling pattern for each pixel, the sampling pattern for consecutive pixels alternating between a first and a second sampling pattern, each sampling pattern defining one or more sampling locations at which sample values are calculated, the sampling locations being relative to a pixel; and

determining a value for at least one pixel by combining sample values calculated for the sampling locations for the pixel.

2. The method of claim 1 wherein each sampling pattern defines two sample locations and calculating sample values comprises calculating a pair of sample values whenever sample values for a pixel are calculated in accordance with the first or second sampling pattern, the sampling patterns alternating from one pixel to the next.

3. The method of claim 2 wherein the pixels of the image are arranged along rows and columns parallel to first and second perpendicular axes, respectively, and the pair of sample locations per sampling pattern for at least two pixels are arranged along a line parallel to neither axis.

4. The method of claim 2 wherein calculating a pair of sample values comprises calculating sample values at sample positions arranged according to either a first or second sampling pattern, the first sampling pattern having sample positions on opposite sides of a line parallel to a first axis and dividing a respective pixel region in two, and the second sampling pattern having sample positions on opposite sides of a line parallel to a second axis and dividing a respective pixel region in two, the second axis perpendicular to the first axis.

5. The method of claim 4 wherein the two lines parallel to the respective axes pass through the centers of respective pixels.

6. The method of claim 5 wherein each sampling pattern has a sample position on each side of both of two lines parallel to respective axes and passing through the center of respective pixels.

7. The method of claim 1 wherein calculating sample values comprises calculating four sample values at four respective sample locations within a respective pixel region whenever a sampling pattern is applied to a pixel, each pixel region considered as divided evenly into a four-by-four array of sub-regions and the four sample locations defined for a pixel by any given sampling pattern arranged within the pixel region in a manner whereby no two sample points defined by the same sampling pattern are located in the same row or column of sub-regions.

8. The method of claim 7 wherein no two sampling locations of the four defined by a given sampling pattern are located in the same row or column or diagonal of sub-regions.

9. The method of claim 8 wherein each sampling location lies substantially at the center of a sub-region.

10. The method of claim 8 wherein no two different sampling patterns applied to two different pixels define any two sampling locations which lie in corresponding sub-regions of their respective pixels.

11. The method of claim 10 wherein the sampling patterns alternate per pixel for vertically-consecutive pixels.

12. The method of claim 10 wherein the sampling patterns alternate per pixel for horizontally-consecutive pixels.

13. The method of claim 10 wherein the sampling patterns alternate per pixel both for horizontally-consecutive pixels and also for vertically-consecutive pixels.

14. A method for generating an image having pixels arranged in rows and columns parallel to first and second perpendicular axes, respectively, the method comprising:

calculating pairs of sample values for pixels of the image in accordance with a plurality of sampling patterns, one sampling pattern per pixel, one pair of sampling points per sampling pattern; and

calculating a value for at least one pixel of the image from a respective pair or pairs of calculated sample values.

15. The method of claim 14 wherein a first sampling pattern defines sample positions relative to a given pixel on opposite sides of a line parallel to a first axis of the image and dividing the respective pixel in two, and a second sampling pattern defines sample positions relative to a given pixel on opposite sides of a line parallel to a second axis of the image and dividing the respective pixel in two.

16. The method of claim 15 wherein the second sampling pattern comprises a sampling pattern substantially corresponding to the first sampling pattern rotated 90°.

17. The method of claim 15 wherein the sampling patterns alternate per pixel along at least one row or column of pixels.

18. The method of claim 15 wherein each of the two sampling patterns is applied to every other pixel along at least one row or column of pixels, the second sampling pattern substantially corresponding to the first sampling pattern rotated 90 degrees.

19. The method of claim 15 wherein the sampling pattern for each consecutive pixel alternates along a row or column of pixels between a given sampling pattern and its 90 degrees-rotated counterpart.

20. The method of claim 14 wherein all sampling patterns are considered as dividing the regions of respective pixels into the same four-by-four array of sub-regions and four potential sample positions are arranged within the array in a manner whereby no two potential sample positions are located in the same row, column, or diagonal of sub-regions, the plurality of sampling patterns comprising first and second sampling patterns, each defining two sampling positions from the four potential sampling positions, the first sampling pattern having sample locations in the first and fourth rows of the array and the second sampling pattern having sample locations in the second and third rows of the array.

21. The method of claim 14 wherein the sampling patterns alternate per pixel along at least one row or column of pixels.

22. The method of claim 14 wherein each of the two sampling patterns is applied to every other pixel along at least one row or column of pixels, the second sampling pattern substantially corresponding to the first sampling pattern rotated 90 degrees.

23. A method for calculating values for pixels of an image having the pixels arranged in rows and columns parallel to first and second perpendicular axes, respectively, the method comprising:

calculating sample values for pixels of the image in accordance with a plurality of sampling rates, the sampling rate differing for at least two pixels of the image; and

calculating values for pixels of the image from respective calculated sample values.

24. The method of claim 23 wherein the sampling rate alternates per pixel for consecutive pixels along lines parallel to one or the other axes of the image for at least some of the horizontal or vertical lines of pixels of the image.

25. The method of claim 23 wherein the sampling rate is constant for the pixels arranged along any given line parallel to the first axis and varies among the plurality of sampling rates for the pixels arranged along any given line parallel to the second axis.

26. The method of claim 25 wherein first and second sampling rates alternate per pixel for consecutive pixels in any line parallel to the second axis.

27. A method for calculating values for pixels of an image having the pixels arranged in rows and columns parallel to first and second perpendicular axes, respectively, the method comprising:

calculating sample values for pixels of the image in accordance with first and second sampling rates, the sampling rate remaining constant for consecutive pixels arranged along any one given line parallel to the first axis and varying between the first and second sampling rates for consecutive pixels arranged along any one given line parallel to the second axis; and

calculating values for pixels of the image from respective calculated sample values.

28. The method of claim 27 wherein the pixels of the image are arranged in rows parallel to the first axis and columns parallel to the second axis, and the first and second sampling rates alternate every row of pixels.

29. The method of claim 27 wherein the first sampling rate is two samples per pixel and the second sampling rate is one sample per pixel.

30. The method of claim 27 wherein the first sampling rate is two samples per pixel and the second sampling rate is one sample per pixel, the two sample locations per pixel for the first sampling rate arranged within a pixel along a line forming an acute angle with respect to either the first or second axes.

31. The method of claim 27 wherein the first sampling rate is two samples per pixel and the second sampling rate is one sample per pixel, the two samples per pixel for the first sampling rate arranged within a pixel substantially along and on opposite sides of a line parallel to either the first or second axes that divides the pixel in two, the axis to which the line is parallel alternating per consecutive pixel arranged along a line parallel to the first axis.

32. The method of claim 31 wherein the two samples per pixel of the first sampling rate vary for every other consecutive pixel lying along a line parallel to the first axis between a given sampling pattern and another sampling pattern which is substantially the same pattern rotated 90 degrees.

33. A method for calculating values for pixels of an image having its pixels arranged in rows and columns parallel to first and second perpendicular axes, respectively, the method comprising:

calculating sample values for pixels of the image in accordance with a sampling pattern having four sample locations relative to a pixel, the region of potential sampling locations considered as divided evenly into a four-by-four array of sub-regions and the four sample locations arranged in a manner whereby no two of the four sample locations are located in the same row or column of sub-regions; and

calculating values for pixels of the image from sample values calculated for respective pixels.

34. The method of claim 33 wherein no two of the four sample locations are located in the same row, column, or diagonal of sub-regions.

35. The method of claim 34 wherein the four sample locations are located substantially at the center of respective sub-regions.

36. The method of claim 34 wherein the four sample locations are located at the center of respective sub-regions.

37. A method for calculating values for pixels of an image, comprising:

calculating sample values for pixels of an image in accordance with a sampling pattern for each pixel, the sampling pattern varying per pixel between a first and a second sampling pattern, each pattern having four sample locations relative to a pixel, the region of potential sampling locations considered as evenly divided into a four-by-four array of sub-regions and the four sample locations arranged in a manner whereby no two of the four sample locations from a given sampling pattern are located along the same row, column, or diagonal of sub-regions; and

determining a value for at least two pixels by combining sample values calculated for the sampling locations for the pixel.

38. The method of claim 37 wherein the first and second sampling patterns alternate per consecutive pixel along at least part of at least one line parallel to a first axis of the image.

39. The method of claim 38 wherein the first and second sampling patterns alternate per consecutive pixel along at least part of at least one line parallel to a second axis of the image, perpendicular to the first axis.

40. A method for calculating values for pixels of an image having its pixels arranged in rows and columns parallel to first and second perpendicular axes, respectively, the method comprising:

calculating sample values for pixels of the image in accordance with one or more sampling patterns, the region of potential sampling locations relative to a pixel considered as divided evenly into a four-by-four array of sub-regions each sampling pattern having at least two sample locations relative to a pixel, each sample location located at one of four candidate sampling locations, and the candidate sampling locations arranged in a manner whereby no two of the four candidate sample locations for a given sampling pattern are located along the same row, column, or diagonal of sub-regions; and

calculating values for pixels of the image from sample values calculated for respective pixels.

41. The method of claim 40 wherein at least one sampling pattern includes at least one other sampling location not located in one of the candidate sampling locations, no more than seven sub-regions containing any sampling location.

42. A method for calculating values for pixels of an image having its pixels arranged in rows and columns parallel to first and second perpendicular axes, respectively, the method comprising:

calculating sample values for pixels of the image in accordance with a sampling pattern, the region of potential sampling locations relative to a pixel considered as divided evenly into a four-by-four array of sub-regions, the sampling pattern having two sample locations relative to a pixel, each sample location located at one of four candidate sampling locations, and the candidate sampling locations arranged in a manner whereby no two of the four candidate sample locations for a given sampling pattern are located along the same row, column, or diagonal of sub-regions; and

calculating values for pixels of the image from sample values calculated for respective pixels.

43. The method of claim 42 wherein the two sample locations are located in the first and fourth rows of the array of sub-regions.

44. The method of claim 43 wherein the two sample locations are located substantially at the center of respective sub-regions.

45. The method of claim 43 wherein the two sample locations are located at the center of respective sub-regions.

46. The method of claim 42 wherein the two sample locations are located in the second and third rows of the array of sub-regions.

47. The method of claim 46 wherein the two sample locations are located substantially at the center of respective sub-regions.

48. The method of claim 46 wherein the two sample locations are located at the center of respective sub-regions.

49. A method for calculating values for pixels of an image having pixels arranged in rows and columns parallel to first and second perpendicular axes, respectively, the method comprising:

calculating sample values for pixels of the image in accordance with a plurality of sampling patterns, each pixel in the image having an associated sampling pattern, the sampling patterns associated with the pixels of a first group of horizontally or vertically consecutive pixels being repeated for at least one following group of the same number of pixels, the same sequence of patterns appearing within at least one following group; and

calculating a final value for a pixel of the image from respective calculated sample values.

50. The method of claim 49 wherein the pixels of the first group are arranged substantially along a line parallel to the first axis and the sampling patterns of the group repeat periodically for subsequent pixels along the same line.

51. The method of claim 50 wherein the pixels of a second group are arranged substantially along a line parallel to the second axis and the sampling patterns of the second group repeat periodically for subsequent pixels along the same line.

52. A method for calculating values for pixels of an image having pixels arranged in rows and columns parallel to first and second perpendicular axes, respectively, the method comprising:

calculating sample values for pixels of the image in accordance with a plurality of sampling patterns; and

calculating values for pixels of the image from respective calculated sample values.

53. The method of claim 52 wherein the plurality of sampling patterns comprises a set of addressable sampling patterns stored in a writable memory.

54. The method of claim 52 wherein the sampling pattern for a given pixel is determined by a calculation based upon the row and/or column containing the pixel.

55. The method of claim 52 wherein determination of the sample locations comprising each sampling pattern is based on a deterministic calculation.

56. The method of claim 53, further comprising selecting one sampling pattern from the plurality of sampling patterns to be applied when calculating sample values for a given pixel.

57. The method of claim 56 wherein selecting the one sampling pattern comprises randomly selecting one sampling pattern from the plurality.

58. The method of claim 56 wherein selection of the one sampling pattern is made in accordance with a pseudo-random selection method.

59. The method of claim 56 wherein selection of the one sampling pattern is made based on the sampling patterns selected for calculating sample values for pixels in the same row or column as the given pixel.

60. The method of claim 56 wherein selection of the one sampling pattern is made based on the row and/or column in which the given pixel lies.

61. The method of claim 60 wherein the sampling patterns define sampling locations substantially at the center of one or more of sixteen different regions, the sixteen regions evenly arranged in a four-by-four array of regions, each of the regions having the same shape and size.

62. A method for calculating values for pixels of an image having pixels arranged in rows and columns parallel to first and second perpendicular axes, respectively, the method comprising:

calculating sample values for pixels of the image in accordance with a fixed set of sampling patterns stored in a read-only memory; and

calculating values for pixels of the image from respective calculated sample values.

63. The method of claim 62 wherein the sampling pattern for a given pixel is determined by a calculation based upon the row and/or column containing the pixel.

64. The method of claim 62, further comprising selecting one sampling pattern from the set of sampling patterns to be applied when calculating sample values for a given pixel.

65. The method of claim 64 wherein selecting one sampling pattern comprises randomly selecting one sampling pattern from the set.

66. The method of claim 64 wherein selection of the one sampling pattern is made in accordance with a pseudo-random selection method.

67. The method of claim 64 wherein selection of the one sampling pattern is made based on the sampling patterns selected for calculating sample values for pixels in the same row or column as the given pixel.

68. The method of claim 64 wherein selection of the one sampling pattern is made based on the row and/or column in which the given pixel lies.

69. The method of claim 68 wherein the sampling patterns define sampling locations substantially at the center of one or more of sixteen different regions, the sixteen regions evenly arranged in a four-by-four array of regions, each region having the same shape and size.

70. A method for calculating values for pixels of an image having the pixels arranged in rows and columns parallel to first and second perpendicular axes, respectively, the method comprising:

shifting the sampling locations defined by one or more sampling patterns relative to a pixel; and

calculating sample values for at least one pixel in accordance with shifted sampling locations of a respective sampling pattern; and

calculating values for pixels from respective calculated sample values.

71. The method of claim 70 wherein the one or more sampling patterns are stored into a writable memory, the sampling pattern applied depending upon those stored in the memory.

72. The method of claim 71 wherein shifting sampling locations for a sampling pattern comprises adding an independently random or pseudorandom offset to each coordinate of each respective sampling location for each pixel.

73. The method of claim 70 wherein shifting the sampling locations of a sampling pattern comprises applying a linear transformation to the coordinates of the sampling locations of the sampling pattern.

74. The method of claim 70 wherein shifting sampling locations for a sampling pattern comprises adding an independently random or pseudorandom offset to each coordinate of each respective sampling location for each pixel.

75. The method of claim 70 wherein shifting the sampling pattern comprises shifting the sampling pattern parallel to either the first or second axis.

76. The method of claim 70 wherein at least one of the sampling patterns comprises a sampling pattern having four sample locations, the four sample locations arranged relative to a pixel within a region evenly divided into an array of 16 sub-regions in a manner whereby no two sample locations are located in the same row, column, or diagonal of sub-regions where the sub-regions are considered as arranged into a four-by-four array of sub-regions.

77. The method of claim 76 wherein shifting sampling locations for the sampling pattern comprises adding an independently random or pseudorandom offset to each coordinate of each of the four sample locations for each pixel.

78. The method of claim 70 wherein at least two of the sampling patterns is considered as dividing a given pixel into a four-by-four array of sub-pixels and four potential sample positions are arranged within the array in a manner where no two potential samples positions are located in the same row, column, or diagonal of sub-pixels, each of the two sampling patterns having two sampling positions from the four potential sampling positions, a first sampling pattern having sample locations in the first and fourth rows of the array and a second sampling pattern having sample locations in the second and third rows of the array.

79. The method of claim 78 wherein shifting sampling locations for the two sampling patterns comprises adding an independently random or pseudorandom offset to each coordinate of each of the two respective sample locations for each pixel.

80. The method of claim 70 wherein one sampling pattern is considered as dividing a given pixel into a four-by-four array of sub-pixels and four potential sample positions are arranged within the array in a manner where no two potential samples positions are located in the same row, column, or diagonal of sub-pixels, the sampling pattern having two sampling positions from the four potential sampling positions, the sampling pattern having sample locations in the first and fourth rows of the array.

81. The method of claim 80 wherein shifting sampling locations for the sampling pattern comprises adding an independently random or pseudorandom offset to each coordinate of each of the two respective sample locations for each pixel.

82. The method of claim 70 wherein one sampling pattern is considered as dividing a given pixel into a four-by-four array of sub-pixels and four potential sample positions are arranged within the array in a manner where no two potential samples positions are located in the same row, column, or diagonal of sub-pixels, the sampling pattern having two sampling positions from the four potential sampling positions, the sampling pattern having sample locations in the second and third rows of the array.

83. The method of claim 82 wherein shifting sampling locations for the two sampling patterns comprises adding an independently random or pseudorandom offset to each coordinate of each of the two respective sample locations for each pixel.

84. The method of claim 70 wherein at least one of the sampling patterns is considered as dividing a given pixel into a four-by-four array of sub-pixels and four potential sample positions are considered to be arranged within the array in a manner whereby no two potential sample positions are located in the same row, column, or diagonal of sub-pixels, the sampling pattern having two sampling positions from the four potential sampling positions.

85. The method of claim 84 wherein shifting sampling locations for the two sampling patterns comprises adding an independently random or pseudorandom offset to each coordinate of each of the two respective sample locations for each pixel.

86. An apparatus for rendering of an image having pixels arranged in rows and columns parallel to first and second perpendicular axes, respectively, the apparatus sampling at a plurality of sample locations relative to a pixel in accordance with a sampling pattern, the sampling pattern for a pixel alternating per pixel between first and second sampling patterns for consecutive pixels arranged along any given line parallel to the first axis and/or for consecutive pixels arranged along any given line parallel to the second axis, the apparatus further calculating values for pixels of the image from respective sample values.

87. An apparatus for rendering of an image having pixels arranged in rows and columns parallel to first and second perpendicular axes, respectively, the apparatus sampling pixels in accordance with at least one sampling pattern having two sample locations, the apparatus further cumulating sample values from and to stored sample values corresponding to the same sampling locations for finally calculating a value for a pixel from a respective pair of stored cumulated sample values.

88. The apparatus of claim 87 wherein a sampling pattern is considered as dividing a given pixel into a four-by-four array of sub-pixels and four potential sample positions are considered to be arranged within the array in a manner whereby no two potential sample positions are located in the same row, column, or diagonal of sub-pixels, at least one sampling pattern having two sampling positions from the four potential sampling positions.

89. An apparatus for rendering of an image having pixels arranged in rows and columns parallel to first and second perpendicular axes, respectively, the apparatus sampling a pixel in accordance with a sampling pattern having four sample locations, the apparatus further

cumulating sample values from and to stored sample values corresponding to the same sampling locations for finally calculating a value for a pixel from respective stored cumulated sample values.

90. The apparatus of claim 89 wherein at least one sampling pattern has its four sample locations arranged relative to a pixel within a region considered as evenly divided into a four-by-four array of sub-regions in a manner whereby no two sample locations are located in the same row, column, or diagonal of sub-regions.

91. An apparatus for rendering of an image having pixels arranged in rows and columns parallel to first and second perpendicular axes, respectively, the apparatus calculating sample values for pixels in accordance with first and second sampling rates, the sampling rate remaining constant for consecutive pixels arranged along any given line parallel to the first axis and the sampling rate varying between the first and second sampling rates for consecutive pixels arranged along any given line parallel to the second axis, the apparatus further calculating values for the pixels of the image from the respective sample values.

92. An apparatus for rendering of an image having pixels arranged in rows and columns parallel to first and second perpendicular axes, respectively, the apparatus sampling pixels in accordance with a sampling pattern having four sample locations, the four sample locations arranged relative to a pixel within a region of potential sampling locations in a manner where no two sample locations are located in the same row, column, or diagonal of sub-regions where the region of potential sampling locations is considered as evenly divided into a four-by-four array of sub-regions, the apparatus further cumulating sample values from and to stored sample values corresponding to the same sampling locations for calculating a value for a pixel from respective sample values.

93. An apparatus for calculating values for pixels of an image, the apparatus comprising:

a first calculating means for calculating sample values at a plurality of sample locations relative to a pixel in accordance with a sampling pattern per pixel, the sampling pattern for a pixel alternating per pixel between a first and second sampling pattern for consecutive pixels arranged along any given line parallel to a first axis of the image and/or for consecutive pixels arranged along any given line parallel to a perpendicular second axis;

a second calculating means for calculating values for pixels by combining respective sample values;

a third calculating means for cumulating sample values; and

a memory means coupled to the first, second, and third calculating means for storing and retrieving cumulated sample values for respective pixels.

94. The apparatus of claim 93 wherein the first calculating means samples two sample locations per pixel in accordance with one per pixel of a plurality of sampling patterns.

95. The apparatus of claim 94 wherein the two sample locations are arranged relative to a pixel substantially along a line forming an acute angle with respect to either first or second axes.

96. The apparatus of claim 94 wherein the two sample locations are arranged according to either a first or second sampling pattern, the first sampling pattern having sample positions on opposite sides of a line parallel to the first axis of the image and dividing a respective pixel region in two, and the second sampling pattern having sample positions on opposite sides of a line parallel to the second axis of the image and dividing the respective pixel region in two.

97. The apparatus of claim 93 wherein each sampling pattern determines four sample locations relative to a pixel, the four sample locations arranged relative to a pixel within a region of potential sample locations, the region considered as evenly divided into a four-by-four array of sub-regions, the sample locations further arranged in a manner whereby no two sample locations in a given sampling pattern are located in the same row, column, or diagonal of sub-regions.